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Status of Atlantic Salmon *(Salmo salar L.)* Populations in Crabbes River and Fischells Brook, Newfoundland, 1998

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ABSTRACT

Adult Atlantic salmon were visually counted in Crabbes River and Fischells Brook, in 1998. The surveys were conducted during the period 26 August to 2 September by swimmers snorkeling down each river. Almost all of the salmon were found in pools, generally with water depths greater than 1 m. An adjustment factor, ranging from 1.0 to 2.0, was applied to the counts in each river section surveyed to account for fish not observed in the larger pools. There were no known removals after the survey, therefore the adjusted count is considered to be the spawning escapement for the river. An estimate of the numbers of salmon hooked-and-released, and numbers retained in the recreational fishery were available from the License Stub Return System. A hook-and-release mortality of 10% was assumed. The estimated total returns to Crabbes River were 491 small and 177 large salmon, and to Fischells Brook was 215 small and 72 large salmon. The percentage of the egg deposition conservation requirement achieved in Crabbes River in 1998 was 44%, which is 54% lower than observed in 1997. In Fischells Brook 23% of the conservation egg deposition requirement was achieved, 48% lower than achieved in 1997. The spawning stock on Fischells Brook is at seriously low levels and it is advised that no fishing mortality be permitted in 1999. The information available did not lend itself to forecasting the abundance of salmon in 1999. The low abundance of small salmon in 1998 may have been due to the severe flooding in February 1996, which could have caused an increase in mortality of juvenile salmon.

RÉSUMÉ

Des saumons de l'Atlantique adultes ont été dénombrés visuellement dans la rivière Crabbes et le ruisseau Fischells en 1998. Les relevés ont été effectués du 26 août au 2 septembre par des plongeurs en apnée qui ont descendu chaque cours d'eau. Pratiquement tous les saumons se trouvaient dans des fosses dont la profondeur était généralement supérieure à 1 m. Un facteur de correction, variant entre 1,0 et 2,0, a été appliqué au dénombrement de chaque segment de cours d'eau inventorié pour tenir compte des poissons non observés se trouvant dans les fosses les plus grandes. Il n'y a pas eu de récolte connue après le relevé de sorte que le dénombrement corrigé est jugé correspondre à l'échappée de géniteurs. Une estimation du nombre de saumons capturés et remis à l'eau et du nombre de poissons conservés par les pêcheurs récréatifs a été obtenue à partir du système de récupération des talons des permis de pêche. Un taux de mortalité de 10 % a été supposé pour les poissons remis à l'eau. Le nombre total estimé de poissons qui sont revenus dans les cours d'eau a été de 491 petits saumons et 177 grands saumons pour la rivière Crabbes et 215 petits et 72 grands saumons pour le ruisseau Fischells. Le pourcentage des dépôts d'œufs nécessaire à la conservation dans la rivière Crabbes en 1998 a été atteinte à 44 %, valeur inférieure de 54 % à celle obtenue en 1997. Dans le ruisseau Fischells, le pourcentage d'oeufs nécessaire à la conservation a été de 23 %, soit 48 % de moins qu'en 1997. Le stock de géniteurs du ruisseau Fischells est sévèrement appauvri et il est déconseillé d'autoriser une mortalité par pêche en 1999. Les renseignements obtenus ne permettaient pas de prévoir l'abondance du saumon en 1999. La faible abondance des petits saumons en 1998 pourrait s'expliquer par l'importante inondation de février 1996, qui pourrait avoir accentué la mortalité chez les saumons juvéniles.

INTRODUCTION

Atlantic salmon populations in Bay St. George rivers declined in the 1970's (Porter and Chadwick 1983) and have been below conservation levels for most of the past 30 years (Reddin and Mullins, 1996). The total returns of salmon to rivers appear to have only marginally increased with the closure of the commercial fisheries in 1992. Direct measurements of salmon population sizes in most rivers are difficult to obtain using conventional fish counting facilities due to the large size of the rivers and their extreme range in discharge.

Reddin and Mullins (1996) conducted assessments of the salmon populations in rivers in Bay St. George, by using angling catch statistics and estimates of angling exploitation rates to estimate population sizes. Visual counts of salmon were successfully used as a means to estimate the numbers of large and small salmon spawners in Crabbes River, Middle Barachois River and Robinsons River in 1996 (Porter 1997) and in Flat Bay Brook (Bourgeois et al. 1997). In 1997, the visual surveys were conducted on these same rivers as well as on Fischells Brook (Porter and Bourgeois 1998). An attempt was made to again conduct visual surveys of these five rivers in 1998. However, due to high water levels, the surveys were only successful on Crabbes River and Fischells Brook (Figures 1 and 2). This document is an assessment of the status of the salmon populations in Crabbes River and Fischells Brook in 1999. The physical characteristics of Crabbes River and Fischells Brook are in Table 1.

METHODS

Recreational Fisheries data

There were hook-and-release recreational fisheries permitted on Crabbes River and Fischells Brook from 6 June to 7 September. There were no retention fishery permitted. Both rivers were closed to angling from 6 - 14 August due to high water temperatures low water levels. Angling data were available from the salmon angler licence stub in 1998.

Unrecorded mortalities

An estimate of all fish killed or naturally died before spawning is important for any stock assessment. Illegal activities do occur on the rivers being assessed; however, no quantitative estimates of salmon mortality are available. The percentage of the released salmon that die will vary with handling techniques and water temperature (Wilkie et al, 1996; and Brobbel et al, 1996). Mortality of hooked-and-released salmon at water temperatures below 20° C is believed to be less than 10%. This value was applied to the estimated number of salmon released for the rivers assessed.

Biological characteristics

The biological characteristics that are used in this assessment are: proportion of large (≥ 63 cm) and small (<63) salmon, mean weight or length and percent female of each size group, and relative fecundity. The values of these parameters determine the reproductive potential of the stock. For Crabbes River and Fischells Brook, the mean weights (1.63 kg for small, 5.06 kg for large) and percentage female (71.9% for small, 86.8% for large salmon) used in this assessment are values for years 1992-94 from Table 6a,b in Reddin & Mullins (1996) (Table 2). The estimated mean fecundity of 1540 eggs/kg of body weight used by Porter & Chadwick (1983) was also used for Crabbes River and Fischells Brook. The proportions of large and small salmon in each population, in 1998, are those that were observed during the visual surveys.

Conservation spawning requirements

Spawning requirements for Atlantic salmon represent an estimate of the number of eggs (or spawners) required for conservation of the stock (O'Connell & Dempson 1995). Juvenile salmon rear in both stream and lake habitat and thus spawning requirements are based on both types (O'Connell & Dempson 1995). The accessible habitat in Crabbes River and Fischells Brook is mostly fluvial with little pond habitat (Table 1). Those lakes that are present are mostly found in the upper part of the watershed and are inaccessible to migrating salmon. Therefore, in relation to the river habitat, the contribution of parr produced in lakes to the total production would be small but still important.

Conservation egg deposition requirements for the five rivers being assessed are those calculated by Reddin & Mullins (1996) as target eggs. These numbers are:

Crabbes River	4,600,000 eggs
Fischells Brook	3,600,000 eggs

The conservation requirements in terms of numbers of spawners requires knowledge of the portion of the eggs which should come from large salmon and from small salmon. Since these rivers are believed to historically have had a significant component of virgin 2SW salmon, it is uncertain how to determine the appropriate number of large salmon that should be in the spawning population to meet its conservation requirements. Since the populations are currently at low levels the observed proportions may not be the appropriate composition for conservation of the large salmon component. The estimates provided in Porter and Bourgeois (1998) are not recommended to be used for fisheries management at this time.

Total Returns to the Rivers and Number of Spawners

Atlantic salmon were visually counted in Crabbes River and Fischells Brook between 26 August and 2 September 1998, by surveyors snorkelling or, where the water was not deep enough, walking

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down each river. Tributaries were not surveyed in 1998 because the larger of the tributaries were surveyed in previous years and few salmon were observed. The tributaries are small and generally had low water levels. The main stem of each river, accessible to sea-run Atlantic salmon, was divided into four or five sections with each section being generally less than 10 km in length (Figs 1 and 2). The method of survey was a modification of that reported by Porter and Bourgeois (1998). Water levels were higher in 1998 than during the surveys in the previous two years. Most Sections of each river were surveyed twice because the high water levels and turbidity limited visibility and few salmon were seen. In the second survey the crew sizes were increased and in large pools a rope was used to hold surveyors in a straight line as they floated or were pulled downstream. The main difference from the 1997 survey was the increase in size of crews and the frequency of using the rope to ensure complete horizontal coverage.

A crew, consisting of four to 11 people, was assigned to each section. For most sections, three to nine surveyors would passively float or swim the river and count salmon, and one or two people would walk the riverbank and record the information provided by the surveyors. A rope was frequently stretched across the river and held in place by two assistants; surveyors would line up across the river along the rope such that there was total horizontal coverage. The assistants would slowly walk down river with the surveyors holding onto the rope. The surveyors would all look in the same direction horizontally across the river and count the salmon that passed between himself/herself and the adjacent surveyor. This technique proved to be very effective and greatly increased the confidence in the estimates of the number of fish in the larger pools. Water depths in most riffle areas were frequently too shallow for swimming, particularly in the upper sections (Sections 1 and 2) of each river.

Information collected included: numbers of large and small salmon, number of salmon with net marks or other injuries and a description of the pools where salmon were observed. Pools were numbered on a map and crossed referenced to a field notebook. If the surveyors were unsure of the count, they would float through the pool a second or third time.

No attempt was made to calibrate differences between teams or individuals since there are many factors that affect accuracy of the counts. These factors include water depth, width of pools, turbidity and colour of water, angle of sun, and light conditions in general.

Some pools were too deep to obtain a complete count of salmon. Therefore, an adjustment factor was applied to the count in each section to obtain an estimate that would include unobserved salmon. This factor was subjectively determined in consultation with the surveyors, taking into consideration the number and size of the pools in which complete counts could not be ascertained, and the number of salmon counted in adjacent pools.

Section 5 of Crabbes River was not surveyed in 1998 due to time constraints. This omission was not considered serious since only small numbers of salmon were observed there in previous years (Porter and Bourgeois 1998). The number of salmon in Section 5 in 1998 was assumed to be in the same proportion to the total river population as the average proportion for 1996 and 1997. Section 2 of Fischells Brook was also not surveyed in 1998. It is a long steady and no salmon were observed in that Section during the survey in 1997. No adjustments were made for the possibility

of salmon in tributaries not surveyed because the tributaries are small and few salmon were found when surveyed in previous years.

The sizing of the salmon by the various survey teams were examined for possible differences or bias by comparing whether or not a particular team consistently recorded a higher or lower number of large salmon than other teams. No bias was found, so no adjustment was made to the proportion of large and small salmon recorded by each team.

The adjusted numbers are believed to represent the total numbers of salmon in each river at the time of the survey. It is assumed that the adjusted numbers of salmon approximate the spawning escapement, since no information is available on mortalities after the survey, and it is believed that the majority of the spawners have entered the river by the time of the survey.

The total returns to each river was obtained by adding the retained catch (if any) and 10% of the hooked-and-released salmon.

Egg deposition

The unadjusted and adjusted egg deposition (ED_{ua} & ED_a) for Crabbes River and Fischells Brook, in 1998, were calculated for small and large salmon separately then summed as follows:

(1) $$ED_{ua} = (UN_S * PF_S * RF_S * MW_S) + (UN_L * PF_L * RF_L * MW_L)$$

(2) $$ED_a = (AN_s * PF_S * RF_S * MW_S) + (AN_L * PF_L * RF_L * MW_L)$$

Where:
$UN_{S \text{ or } L}$ = unadjusted numbers of small or large salmon counted in the survey
$PF_{S \text{ or } L}$ = percent female small or large salmon
$MW_{S \text{ or } L}$ = mean weight for small or large salmon
$RF_{S \text{ or } L}$ = relative fecundity for small or large salmon (1540 eggs/kg)
$AN_{S \text{ or } L}$ = adjusted number of small or large salmon counted in the survey

Percentage of Conservation Level Achieved

The adjusted and unadjusted percentage of the conservation egg deposition levels achieved in each river were calculated as follows:

(3) Percentage of conservation level achieved = $(ED_{ua \text{ or } a} / CED) * 100$

Where: CED = egg deposition required for Conservation

RESULTS

Recreational Fisheries Data

The angling catch statistics for 1998 for the five rivers assessed, as compiled from the angling license stub returns, are provided in Table 3. The catch statistics from 1974-98 are also provided in Appendices 1 and 2; however, it should be noted that the statistics prior to 1996 were derived from River Monitors or Fisheries Guardians and may not be directly comparable to the data derived from the license stub returns 1996-98.

Some anglers reported retaining small salmon on Fischells Brook even though the river was only open for hook-and-release angling. The estimate total numbers of small and large salmon released in 1998 was considerably lower than in 1997.

Unrecorded Mortalities

The estimated mortality due to angling on Crabbes River in 1998 was 9 small and 6 large salmon, and on Fischells Brook, it was 21 small and no large salmon (Table 3).

Biological Characteristics

The parameter values for mean weights, and percent female are in Table 2. The percentage of large salmon in each population, in 1998, is shown in Tables 4 and 5.

Conservation Spawning Requirements

Crabbes River requires $4.6*10^6$ eggs deposited to attain its conservation requirement and Fischells Brook requires $3.6*10^6$ eggs

Number of Spawners and Total Returns to Rivers

The unadjusted and the adjusted numbers of small and large salmon counted in Crabbes River and Fischells Brook are provided in Tables 4 and 5. There were only 10 pools on Crabbes River and four on Fischells Brook that contained more than 10 salmon. Few salmon were found in riffles or in pools less than one meter in depth. The adjustment factor applied to the actual counts varied depending on river section, and ranged from 1.10 to 2.0 on Crabbes River and 1.0 to 2.0 on Fischells Brook.

In Crabbes River the greatest number of small salmon were found in Section 2, and the greatest number of large salmon were found in Section 3. In Fischells River most of the salmon were found in Section 1.

The adjusted counts of small and large salmon are assumed to be the number of fish that spawned in each river since there were no known removals subsequent to the survey. It is estimated that there were 482 small and 171 large salmon spawners in Crabbes River and 194 small and 72 large salmon in Fischells Brook in 1998 (Table 6). A summary of the estimated historical spawning escapements for these two rivers is provided in Table 7.

The total returns to each river was estimated by adding an estimate of mortalities (angled salmon retained fish plus 10% of released fish) (Table 3) to the estimated numbers of spawners (Table 6). The total returns of small salmon was 491 on Crabbes River and 215 on Fischells Brook, and the total returns of large salmon were 177 and 72 respectively (Table 8).

Egg Deposition

The estimated egg deposition and percentage of conservation level achieved are provide in Table 6, and summarized below:

River	Egg Deposition	% Conservation achieved
Crabbes River	$4.4*10^6$	44
Fischells Brook	$1.6*10^6$	23

The percentages of the egg deposition required for conservation that were attained, 1953-98 in each river are provided in Table 9.

There were 13 salmon observed in Crabbes River with external marks and two in Fischells Brook in 1998.

DISCUSSION

The status of the salmon stocks in Crabbes River and Fischells Brook in 1998 declined from that observed in 1997 by Porter and Bourgeois (1998) (Table 9). The egg deposition in Fischells Brook has been seriously low in both 1997 and 1998. There should not be any fishing mortality on this stock in 1999.

The percentage of the spawning escapement that was large salmon on Crabbes River in 1998 is similar to that observed in 1997. Whereas, on Fischells Brook the percentage large salmon more than doubled in 1998 (see table below).

	Percent large salmon		
	1996	1997	1998
Crabbes River	22.1	23.6	26.2
Fischells Brook	N/A	10.8	27.0

Since the biological characteristics (Table 2) used in this assessment are default, the calculations of egg deposition have an associated error related to possible in appropriate parameter values. River specific data on weights and sex ratio are required to improve the stock assessment on these rivers.

The use of more surveyors in the larger pools and the application of a rope to keep the surveyors on a straight line across the river vastly improved the technique for counting fish. There is still a problem of counting fish in pools too deep to see the bottom. A further refinement is required.

This low production in 1998 may be a result of the severe flooding that occurred in February 1996, which could have killed juvenile salmon in both rivers. The effects of this flood may be evident again in 1999.

REFERENCES

Bourgeois, C. E, J. P. Davis, J. Murray and V. Mercer. 1997. Status of three Atlantic salmon (*Salmon salar* L.) stocks of the Newfoundland Region in 1996. DFO Canadian Stock Assessment Secretariat Res. Doc.1997/33, 33pp.

Brobbel, M. A., M. P. Wilkie, J.D. Kieffer, and B. L. Tufts. 1996. Physiological effects of catch and release angling in Atlantic salmon (*Salmo salar*) at different stages of freshwater migration. Can. J. Fish. Aquat. Sci. 53: 2036-2043.

O' Connell, M. F., and J. B. Dempson. 1995. Target spawning requirements for Atlantic salmon, *Salmo salar* L., in Newfoundland rivers. Fisheries Management and Ecology 2: 161-170.

Porter, T. Rex. 1997. Status of Atlantic salmon (*Salmon salar* L.) Populations in Crabbes, Robinsons, and Middle Barachois Rivers, Bay St. George, Newfoundland, 1996. DFO Canadian Stock Assessment Secretariat Res. Doc.1997/43, 25 pp.

Porter, T. R., and C. E. Bourgeois. 1998. Status of Atlantic salmon (*Salmo salar* L.) populations in Crabbes and Robinsons rivers, and Middle Barachois, Fischells, and Flat Bay brooks, Bay St. George, Newfoundland, 1997. DFO Canadian Stock Assessment Secretariat Res. Doc. 1998/112, 35pp.

Porter, T. R., and E. M. P. Chadwick. 1983. Assessment of Atlantic salmon stocks in Statistical Areas K and L, Western Newfoundland, 1982. CAFSAC Res. Doc. 83/87, 84 p.

Reddin, D. G. and C. C. Mullins. 1996. Status of Atlantic Salmon (*Salmo salar*) in eleven rivers of Bay St. George (SFA 13), Newfoundland, 1994. DFO Atlantic Fisheries Res. Doc. 96/86, 71p.

Wilkie, M. P., Davidson, K., Brobbel, M. A., Kieffer, J. D., Booth, R.K., Bielak, A. T., and Tufts, B. L. 1996. Physiology and survival of wild salmon following angling in warm summer waters. Trans. Am. Fish. Soc. 125: 572-580.

Table 1. Drainage area, fluvial habitat, and egg deposition levels required for conservation in Crabbes River and Fischells Brook

RIVER NAME	DRAINAGE AREA (sq. km)	FLUVIAL REARING UNITS (100 sq. m)	STANDING WATER (ha)	Conservation Requirement EGGS (x 10**6)
CrabbesRiver	551	18,429	381	4.6
Fischells River	360	13,661	948	3.6

Table 2. Biological characteristics for Crabbes River and Fischells Brook.

River	Small Salmon				Large salmon			
	% of Total	% Female	Mean Wt(kg)	Mean Lth(cm)	% of Total	% Female	Mean Wt(kg)	Mean Lgth(cm)
Crabbes	77.1	71.9	1.63	N/A	22.9	86.8	5.06	N/A
Fischells	90.26	71.9	1.63	N/A	9.7	86.8	5.06	N/A
Total								

Table 3. Retained and released salmon angled on Crabbes River and Fischells Brook in 1998, as derived from the angler license stub return. Estimated mortality is the sum of the retained salmon and 10% of the released salmon. Percent (%) of returns is the percent of total returns to the river.

Small salmon

	Crabbes		Fischells	
	Fish	% of returns	Fish	% of returns
Retained	0	0	17	8
Released	91	16	36	17
Estimated Mortality	9	2	21	10

Large salmon

	Crabbes		Fischells	
	Fish	% of returns	Fish	% of returns
Retained	0	0	0	0
Released	55	31	4	6
Estimated Mortality	6	3	0	0

Table 4. Number of small and large salmon counted in Crabbes River, 26 & 31 August 1998.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	2	90	38	1.10	99	42	141	29.7
2	4	199	32	1.25	249	40	289	13.9
3	4	77	65	1.25	96	81	178	45.8
4	0	8	2	2.00	16	4	20	20.0
5	Not Surveyed				22	4	26	15.4
L Crabbes	Not Surveyed				0	0	0	
TOTAL	10	374	137	1.28	482	171	653	26.2

Table 5. Number of small and large salmon counted in Fischells Brook, 1 & 2 September 1998

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	1	96	54	1.20	115	65	180	36.0
2	Not Surveyed			1.00	0	0	0	0.0
3	3	64	4	1.20	77	5	82	5.9
4	0	1	1	2.00	2	2	4	50.0
TOTAL	4	161	59	1.21	194	72	266	27.0

Table 6. Adjusted and unadjusted numbers of small and large spawners, estimated egg deposition, and percentage of egg deposition required for conservation attained in Crabbes River and Fischells Bk in 1998.

River	Small salmon		Large salmon		Egg deposition		% Conservation level	
	unadjust	adjusted	unadjust	adjusted	unadjust	adjusted	unadjust	adjusted
Crabbes River	374	482	137	171	1601649	2026540	35	44
Fischells River	161	194	59	72	689643	837132	19	23

Table 7. Spawning escapement of Atlantic salmon in Crabbes River and Fischells Brook, 1953-98. Estimates for 1953-94 are from Reddin and Mullins (1996). Estimates for 1996 and 1997 are from Porter and Bourgeois (1998)

	Crabbes		Fischells	
Year	Small	Large	Small	Large
1953	166	51	226	57
1954	271	77	79	65
1955	177	149	75	68
1956	420	329	343	104
1957	772	467	425	117
1958	313	411	364	149
1959	551	276	336	47
1960	343	75	222	57
1961	756	168	450	108
1962	1328	294	658	86
1963	1092	450	992	180
1964	1909	437	712	204
1965	1003	363	471	126
1966	293	127	64	45
1967	593	164	434	33
1968	552	186	339	36
1969	1018	191	508	63
1970	370	123	369	110
1971	379	70	292	22
1972	486	124	163	52
1973	407	87	490	68
1974	359	80	269	22
1975	330	74	225	17
1976	233	47	226	13
1977	265	103	299	54
1978	333	270	397	321
1979	553	30	173	0
1980	877	193	585	415
1981	940	244	701	114
1982	1355	159	919	73
1983	254	97	330	79
1984	952	30	551	83
1985	129	30	216	20
1986	472	108	274	26
1987	114	26	88	8
1988	386	89	556	53
1989	64	15	25	2
1990	152	35	173	16
1991	140	32	234	22
1992	393	126	210	21
1993	204	34	234	65
1994	600	113	844	158
1995	N/A	N/A	N/A	N/A
1996	844	239	N/A	N/A
1997	1121	346	599	73
1998	482	171	194	72
Mean 53-65	700	273	412	105
Mean 66-77	441	115	306	44
Mean 78-84	752	146	522	155
Mean 85-91	208	48	224	21
Mean 92-94	399	91	429	82
Mean 96-98	816	252	397	73

Table 8. Estimated total returns to Crabbes River and Fischells Brook,1953-98. Estimates for 1953-94 are from Reddin and Mullins (1996). Estimates for 1996 and 1997 are from Porter and Bourgeois (1998).

	Crabbes		Fishells	
Year	Small	Large	Small	Large
1953	237	85	323	95
1954	387	128	113	108
1955	253	248	107	113
1956	600	548	490	173
1957	1103	778	607	195
1958	447	685	520	248
1959	787	460	480	78
1960	490	125	317	95
1961	1080	280	643	180
1962	1897	490	940	143
1963	1560	750	1417	300
1964	2727	728	1017	340
1965	1433	605	673	210
1966	533	282	116	100
1967	1078	365	789	73
1968	1004	413	616	80
1969	1851	425	924	140
1970	673	273	671	245
1971	689	155	531	49
1972	884	276	296	115
1973	740	193	891	147
1974	653	178	489	49
1975	600	164	409	38
1976	424	105	411	29
1977	482	229	544	120
1978	471	397	551	352
1979	782	44	240	0
1980	1240	284	812	455
1981	1329	359	973	125
1982	1916	234	1276	80
1983	359	119	458	80
1984	1346	44	765	91
1985	224	30	361	20
1986	819	108	458	26
1987	198	26	147	8
1988	670	89	930	53
1989	111	15	42	2
1990	264	35	289	16
1991	243	32	391	22
1992	682	126	351	21
1993	354	34	391	65
1994	774	113	1060	158
1995	N/A	N/A	N/A	N/A
1996	844	239	N/A	N/A
1997	1152	358	797	86
1998	491	177	215	72
Mean 53-65	1000	454	588	175
Mean 66-77	801	255	557	99
Mean 78-84	1063	212	725	169
Mean 85-91	361	48	374	21
Mean 92-94	603	91	600	82
Mean 96-98	829	258	506	79

Table 9. Percentage of the egg deposition level required for conservation acheived on Crabbes River and Fischells Brook, 1953-98. Estimates for 1953-94 are from Reddin and Mullins (1996). Estimates for 1996 and 1997 are from Porter and Bourgeois (1998).

Year	Crabbes	Fishells
1953	10	18
1954	15	15
1955	20	15
1956	46	30
1957	69	35
1958	52	39
1959	43	20
1960	17	18
1961	37	35
1962	64	37
1963	75	66
1964	94	61
1965	64	39
1966	19	10
1967	28	21
1968	30	18
1969	38	29
1970	20	33
1971	14	14
1972	22	15
1973	16	29
1974	15	13
1975	14	11
1976	9	10
1977	16	20
1978	38	72
1979	19	6
1980	45	96
1981	52	44
1982	55	43
1983	17	25
1984	30	33
1985	6	10
1986	24	13
1987	6	4
1988	19	26
1989	3	1
1990	8	8
1991	7	11
1992	34	14
1993	13	24
1994	41	71
1995	N/A	N/A
1996	68	N/A
1997	95	44
1998	44	23
Mean 53-65	47	33
Mean 66-77	20	19
Mean 78-84	37	46
Mean 85-91	10	10
Mean 92-94	29	36
Mean 96-98	69	34

Fig. 1. Sections of Crabbes River and Little Crabbes Brook in which visual surveys were conducted, 1998.

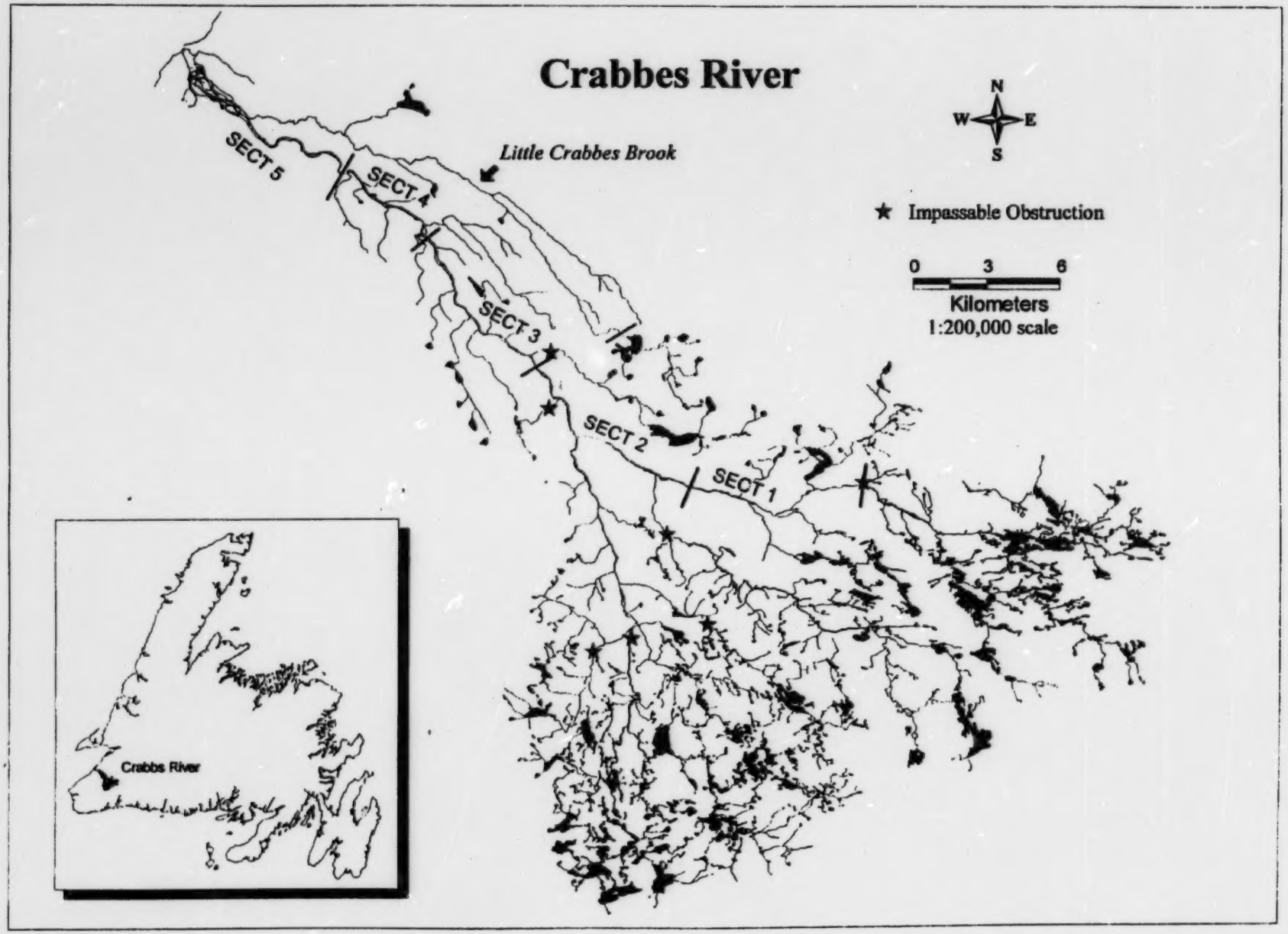
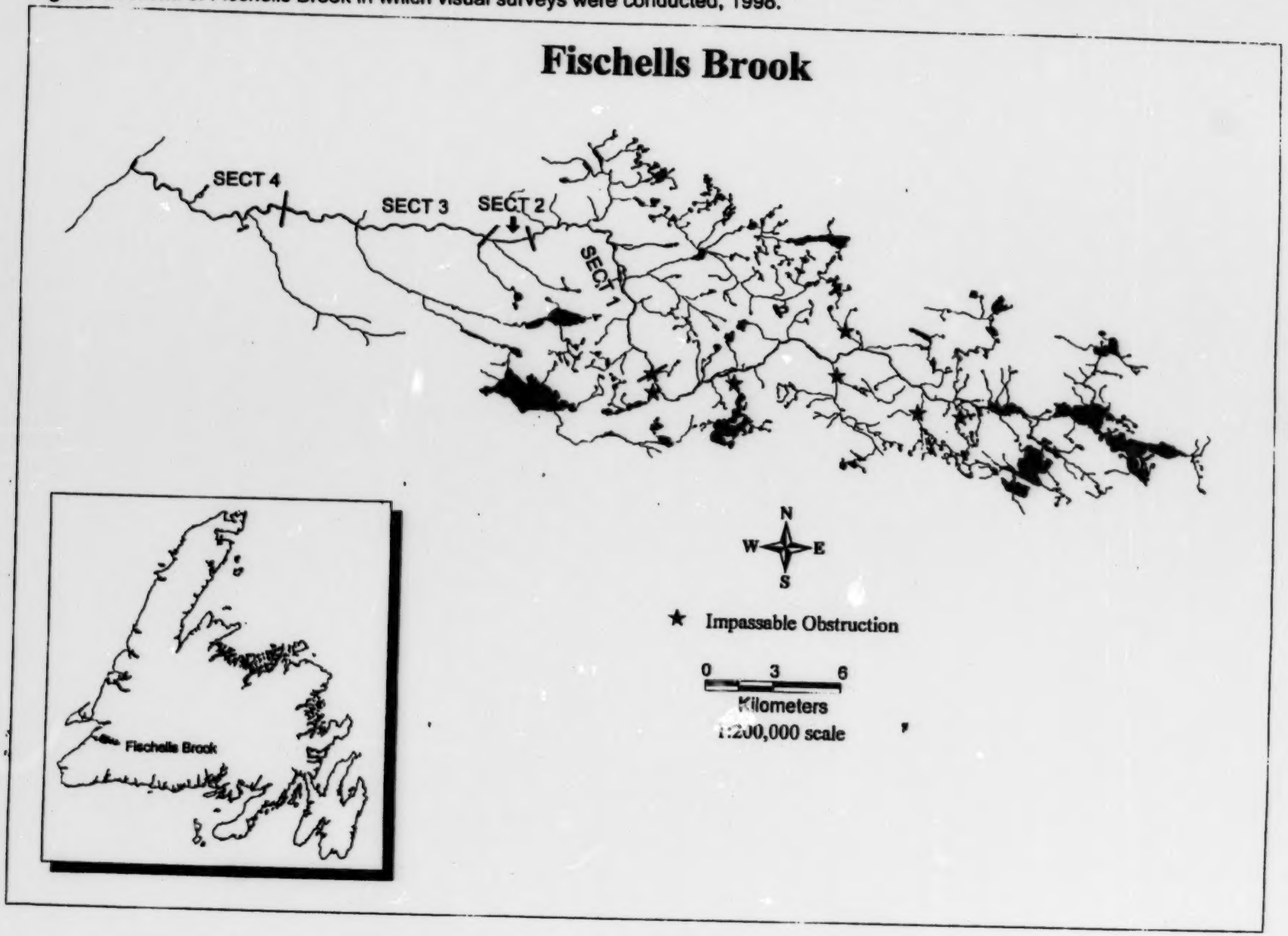


Fig. 2. Sections of Fischells Brook in which visual surveys were conducted, 1998.



Appendix 1. Angling catch statistics for Crabbes River. Data for 1974-1995 were collected by DFO River Guardians, and data for 1996-1998 are from the license stub return.

River: Crabbes River

Code: 4000860

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1010	294	.	294	98	.	98	392	.	392	0.39
1975	1641	270	.	270	90	.	90	360	.	360	0.22
1976	859	191	.	191	58	.	58	249	.	249	0.29
1977	859	217	.	217	126	.	126	343	.	343	0.40
1978	907	138	.	138	127	.	127	265	.	265	0.29
1979	501	229	.	229	14	.	14	243	.	243	0.49
1980	902	363	.	363	91	.	91	454	.	454	0.50
1981	905	389	.	389	115	.	115	504	.	504	0.56
1982	1135	561	.	561	75	.	75	636	.	636	0.56
1983	758	105	.	105	38	.	38	143	.	143	0.19
1984	848	394	.	394	14	.	14	408	.	408	0.48
1985	602	95	.	95	*	3	3	95	3	98	0.16
1986	997	347	.	347	*	0	0	347	0	347	0.35
1987	377	84	.	84	*	4	4	84	4	88	0.23
1988	773	284	.	284	*	17	17	284	17	301	0.39
1989	419	47	.	47	*	5	5	47	5	52	0.12
1990	457	112	.	112	*	25	25	112	25	137	0.30
1991	385	103	.	103	*	9	9	103	9	112	0.29
1992	822	263	26	289	*	88	88	263	114	377	0.46
1993	737	150	0	150	*	24	24	150	24	174	0.24
1994	906	174	37	211	*	45	45	174	82	256	0.28
1995	268	26	5	31	*	32	32	26	37	63	0.24
1996**		-	221	221	*	96	96	-	317	317	
1997**		3	278	281	*	119	119	3	397	400	
1998**		-	91	91	*	55	55	-	146	146	
84-89 $\bar{X}$	669.3	208.5	.	208.5	.	5.8	7.2	210.8	5.8	215.7	0.32
95% CI.	258.3	158.3	.	158.3	.	8.1	7.1	162.0	8.1	161.6	0.14
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	568.0	162.8	.	162.8	.	10.0	10.0	162.8	10.0	172.8	0.30
95% CL	269.9	128.0	.	128.0	.	9.8	9.8	128.0	9.8	127.3	0.09
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	683.3	153.3	17.0	170.3	.	47.3	47.3	153.3	64.3	217.5	0.32
95% CL	453.9	155.6	27.8	173.2	.	45.4	45.4	155.6	65.9	210.8	0.18
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN.

1996-1998 CATCH AND RELEASE ONLY

Appendix 2. Angling catch statistics for Fischells Brook. Data for 1974-1995 were collected by DFO River Guardians, data for 1996-98 are from the license stub return.

River: Fischells Brook

Code: 4000960

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	753	220	.	220	27	.	27	247	.	247	0.33
1975	522	184	.	184	21	.	21	205	.	205	0.39
1976	418	185	.	185	16	.	16	201	.	201	0.48
1977	468	245	.	245	66	.	66	311	.	311	0.66
1978	292	154	.	154	31	.	31	185	.	185	0.63
1979	168	67	.	67	0	.	0	67	.	67	0.40
1980	386	227	.	227	40	.	40	267	.	267	0.69
1981	463	272	.	272	11	.	11	283	.	283	0.61
1982	651	357	.	357	7	.	7	364	.	364	0.56
1983	377	128	.	128	7	.	7	135	.	135	0.36
1984	411	214	.	214	8	.	8	222	.	222	0.54
1985	373	145	.	145	*	3	3	145	3	148	0.40
1986	427	184	.	184	*	4	4	184	4	188	0.44
1987	266	59	.	59	*	2	2	59	2	61	0.23
1988	840	374	.	374	*	7	7	374	7	381	0.45
1989	110	17	.	17	*	0	0	17	0	17	0.15
1990	256	116	.	116	*	12	12	116	12	128	0.50
1991	414	157	.	157	*	16	16	157	16	173	0.42
1992	384	133	8	141	*	11	11	133	19	152	0.40
1993	819	157	0	157	*	34	34	157	34	191	0.23
1994	702	216	58	274	*	47	47	216	105	321	0.46
1995	555	80	112	192	*	43	43	80	155	235	0.42
1996**		315	232	547	*	150	150	315	382	697	
1997**		182	162	344	*	127	127	182	289	471	
1998**		17	36	53	*	4	4	17	40	57	
84-89 $\bar{X}$	404.5	165.5	.	165.5	.	3.2	4.0	166.8	3.2	169.5	0.42
95% CL	255.9	132.8	.	132.8	.	3.2	3.2	133.4	3.2	135.5	0.10
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	385.5	151.2	.	151.2	.	6.8	6.8	151.2	6.8	158.0	0.41
95% CL	263.9	131.5	.	131.5	.	6.5	6.5	131.5	6.5	133.6	0.09
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	615.0	146.5	44.5	191.0	.	33.8	33.8	146.5	78.3	224.8	0.37
95% CL	299.3	89.7	82.4	94.3	.	25.6	25.6	89.7	100.9	115.5	0.20
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN.

1998 CATCH AND RELEASE ONLY.